

FORM PTO-1390 (Modified) (REV. 11-98)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER JMYT-251US	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR) <div style="font-size: 1.5em; font-weight: bold; text-align: center;">10/018520</div>	
INTERNATIONAL APPLICATION NO. PCT/GB00/02202		INTERNATIONAL FILING DATE 07 June 2000 (07.06.00)		PRIORITY DATE CLAIMED 15 June 1999 (15.06.99)	
TITLE OF INVENTION IMPROVEMENTS IN EMISSIONS CONTROL					
APPLICANT(S) FOR DO/EO/US HAWKER, Pelham Nigel					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<ol style="list-style-type: none"> 1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1). 4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date. 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2)) <ol style="list-style-type: none"> a. <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> has been transmitted by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)). 7. <input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210). 8. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)) <ol style="list-style-type: none"> a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> have been transmitted by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input checked="" type="checkbox"/> have not been made and will not be made. 9. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 10. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)). (UNEXECUTED) 11. <input checked="" type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409). 12. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)). 					
Items 13 to 20 below concern document(s) or information included:					
<ol style="list-style-type: none"> 13. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 14. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 15. <input checked="" type="checkbox"/> A FIRST preliminary amendment. 16. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. 17. <input type="checkbox"/> A substitute specification. 18. <input type="checkbox"/> A change of power of attorney and/or address letter. 19. <input checked="" type="checkbox"/> Certificate of Mailing by Express Mail 20. <input type="checkbox"/> Other items or information: 					

1005 Rec'd PCT/PTO 14 DEC 2001

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.53) 10/018520		INTERNATIONAL APPLICATION NO. PCT/GB00/02202		ATTORNEY'S DOCKET NUMBER JMYT-251US	
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21. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **\$970.00**

☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **\$840.00**

☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **\$690.00**

☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **\$670.00**

☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **\$96.00**

ENTER APPROPRIATE BASIC FEE AMOUNT =

CALCULATIONS PTO USE ONLY

\$890.00

Surcharge of **\$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	8 - 20 =	0	x \$18.00	\$0.00
Independent claims	2 - 3 =	0	x \$84.00	\$0.00
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				\$0.00
TOTAL OF ABOVE CALCULATIONS =				\$890.00

Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). ☐

\$0.00

SUBTOTAL =

\$890.00

Processing fee of **\$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).

TOTAL NATIONAL FEE =

\$890.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). ☐

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TOTAL FEES ENCLOSED =

\$890.00

	Amount to be:	
	refunded	\$
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☒ A check in the amount of **\$890.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.

A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required; or credit any overpayment to Deposit Account No. **18-0350** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Andrew L. Ney
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20,300
REGISTRATION NUMBER

December 14, 2001
DATE

Page 2 of 2

JMYT-251US

10/018520
PATENT
JC05 Rec'd PCT/PTO 14 DEC 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Pelham Nigel Hawker : Art Unit:
Application No.: To Be Assigned : Examiner:
Filed: Herewith :
FOR: IMPROVEMENTS IN EMISSIONS :
CONTROL

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

SIR:

Prior to examination, please amend the above-identified
application as follows.

IN THE SPECIFICATION:

Please add the following paragraph at page 1, after the title:

This application is the U.S. national phase application of PCT
International Application No. PCT/GB00/02202.

IN THE CLAIMS:

Please replace claims 1, 4, 6, and 7 with the following amended
claims:

- 1 1. (Amended) A diesel engine provided with an exhaust
- 2 system comprising oxidation catalyst, a particulate trap and an exhaust gas
- 3 recirculation system ("EGR"), wherein the EGR system intake is mounted
- 4 downstream of the oxidation catalyst, so that the portion of recirculated
- 5 exhaust gas passes through the oxidation catalyst, characterised in that the
- 6 particulate trap is downstream of the EGR system intake.

JMYT-250US

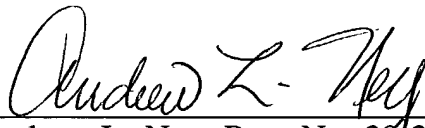
- 2 -

1 4. (Amended) A system according to claim 1 wherein the
2 particulate trap is effective to trap at least 50% by wt of particulates in the
3 exhaust gas.

1 6. (Amended) A system according to claim 1, wherein the
2 recirculation ratio of the EGR system may be varied from 5 to 30% by
3 volume.

1 7. (Amended) A system according to claim 1, comprising a
2 cooler for the recirculated gases, said cooler being mounted upstream of an
3 EGR valve.

Respectfully submitted,



Andrew L. Ney, Reg. No. 20,300
Attorneys for Applicant

CRL/lrb

Enclosure: Version with Markings to Show Changes Made

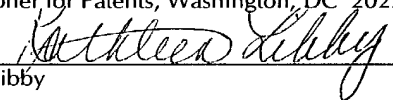
Dated: December 14, 2001

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The Assistant Commissioner for Patents is
hereby authorized to charge payment to
Deposit Account No. 18-0350 of any fees
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I hereby certify that this paper and fee are being deposited,
under 37 C.F.R. § 1.10, and with sufficient postage, using
the "Express Mail Post Office to Addressee" service of the
United States Postal Service on the date indicated above
and that the deposit is addressed to the Assistant
Commissioner for Patents, Washington, DC 20231.



Kathleen Libby

VERSION WITH MARKINGS TO SHOW CHANGES MADEIN THE SPECIFICATION:

At page 1, after the title:

This application is the U.S. national phase application of PCT International Application No. PCT/GB00/02202.

IN THE CLAIMS:

1 1. (Amended) A diesel engine-(1) provided with an exhaust
2 system-(4) comprising oxidation catalyst-(5a), a particulate trap-(5b) and an
3 exhaust gas recirculation system ("EGR"), wherein the EGR system intake
4 (6) is mounted downstream of the oxidation catalyst, so that the portion of
5 recirculated exhaust gas passes through the oxidation catalyst, characterised
6 in that the particulate trap is downstream of the EGR system intake.

1 4. (Amended) A system according to claim 1, 2 or 3,
2 wherein the particulate trap is effective to trap at least 50% by wt of
3 particulates in the exhaust gas.

1 6. (Amended) A system according to ~~any preceding~~ claim
2 1, wherein the recirculation ratio of the EGR system may be varied from 5 to
3 30% by volume.

1 7. (Amended) A system according to ~~any preceding~~ claim
2 1, comprising a cooler-(7) for the recirculated gases, said cooler being
3 mounted upstream of an EGR valve-(8).

1/PRT

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1

IMPROVEMENTS IN EMISSIONS CONTROL

5

The present invention concerns improvements in emissions control. More especially, the invention concerns improvements in the control of particulates and NO_x from diesel engines.

10 The use of emission control catalysts for engine exhaust clean-up is well established. Diesel engines have different characteristics from gasoline-fuelled engines, with a different mix of pollutants caused by the different fuels, the different combustion characteristics in each engine and the lower temperatures met with in exhausts from diesel engines. Additionally, diesel engines emit more noticeable particulates, especially under heavy load
15 and upon start-up, than gasoline engines. In general, it can be said that diesel engines emit less NO_x than a gasoline engine under most conditions, but because diesel engines mostly or exclusively operate on a high air to fuel ratio, that is are "lean"-burn engines, the chemistry of the exhaust gas does not favour NO_x reduction by aftertreatment, because of the excess of oxidising species. There are engine design options available, which can
20 reduce the quantities of NO_x or of particulates but not both simultaneously.

To meet the various emission regulations already or about to enter force, it has become necessary to treat diesel exhausts in various ways. Oxidation catalysts, which catalyse the oxidation of unburnt hydrocarbons ("HCs") and carbon monoxide ("CO") are
25 now regularly fitted to light duty diesels, and particulate traps of various types are becoming commonplace on heavy duty diesels as used in trucks, buses and some stationary engines. A technique for reducing gas emissions, especially NO_x emissions from diesel engines is exhaust gas recirculation ("EGR"), which takes a proportion of the exhaust gas and recirculates it into the engine cylinders. Generally, about 30 up to 75vol% of the exhaust
30 gases are recirculated, depending upon the characteristics of the particular engine and the emission limits which must be met. Although EGR has been used with gasoline engines for many years, principally to improve fuel economy, it has only been more recently fitted to diesel engines; we believe that most diesel vehicles currently fitted with EGR are passenger car light duty diesel engines. In the case of engines fitted with a catalyst, the exhaust gas is
35 believed to be always taken from upstream of the catalyst in practical applications. A system

incorporating EGR and catalysts, believed to be applied to gasoline engines, is described in DE 19853119, where EGR gas flow is taken downstream of a close-coupled starter catalyst, but upstream of the main three way catalyst. It is generally expected that EGR would have a significant beneficial effect on emissions from heavy duty diesel engines, that is those fitted to heavy trucks and buses. Because of the engineering problems caused by the very different exhaust characteristics compared to light duty diesel engines, however, this has proved difficult to achieve. In particular, there is currently no commercial source of an EGR valve of suitable size and materials to be fitted to a heavy duty diesel engine.

We refer also to a device marketed as the "CRTTM" by Johnson Matthey PLC. This device is described in US Patent No 4,902,487 and is a continuously regenerative particulate trap. Unlike the vast majority of particulate traps, however, this device regenerates continuously or semi-continuously *in situ* without the need for periodic replacement or electrical heating to ignite the soot. Such device relies upon a catalyst system which generates NO₂ which has proved to be effective to cause low temperature combustion of trapped soot particles.

The principle of the CRT has been adopted by Hino in their published Japanese patent applications JP 8338320 and JP 9088727, in combination with EGR. However, such systems as described are not believed to be capable of use in true heavy duty diesel applications.

JP6066208 describes a diesel engine with EGR as well as an oxidation catalyst and a soot trap (or filter). However, it is clear that the EGR gas flow is taken from the engine without passing through any catalyst or any filter. The recycled gas is first filtered, then passed through an oxidation catalyst. We believe that the benefits from such a system do not match those from our own developments.

We have recently disclosed in WO 99/09307 a novel combination which can offer very low levels of NO_x. That invention provides a diesel engine system comprising a diesel engine and an exhaust system therefor, characterised in that the exhaust system

incorporates a catalyst effective to convert NO to NO₂ under normal operating conditions,
5 a trap for particulates mounted downstream of the catalyst and an exhaust gas recirculation
system mounted downstream of the trap, and provided with cooling means to cool the
portion of exhaust gas which is recirculated.

DE-A-4007516 describes a diesel engine including an exhaust system having an
10 oxidation catalyst and a particulate trap located downstream thereof.

It is noted that the gases for exhaust gas recirculation in WO 99/09307 and
DE-A-4007516 are taken downstream of the trap, thus benefitting from reduced particulate.

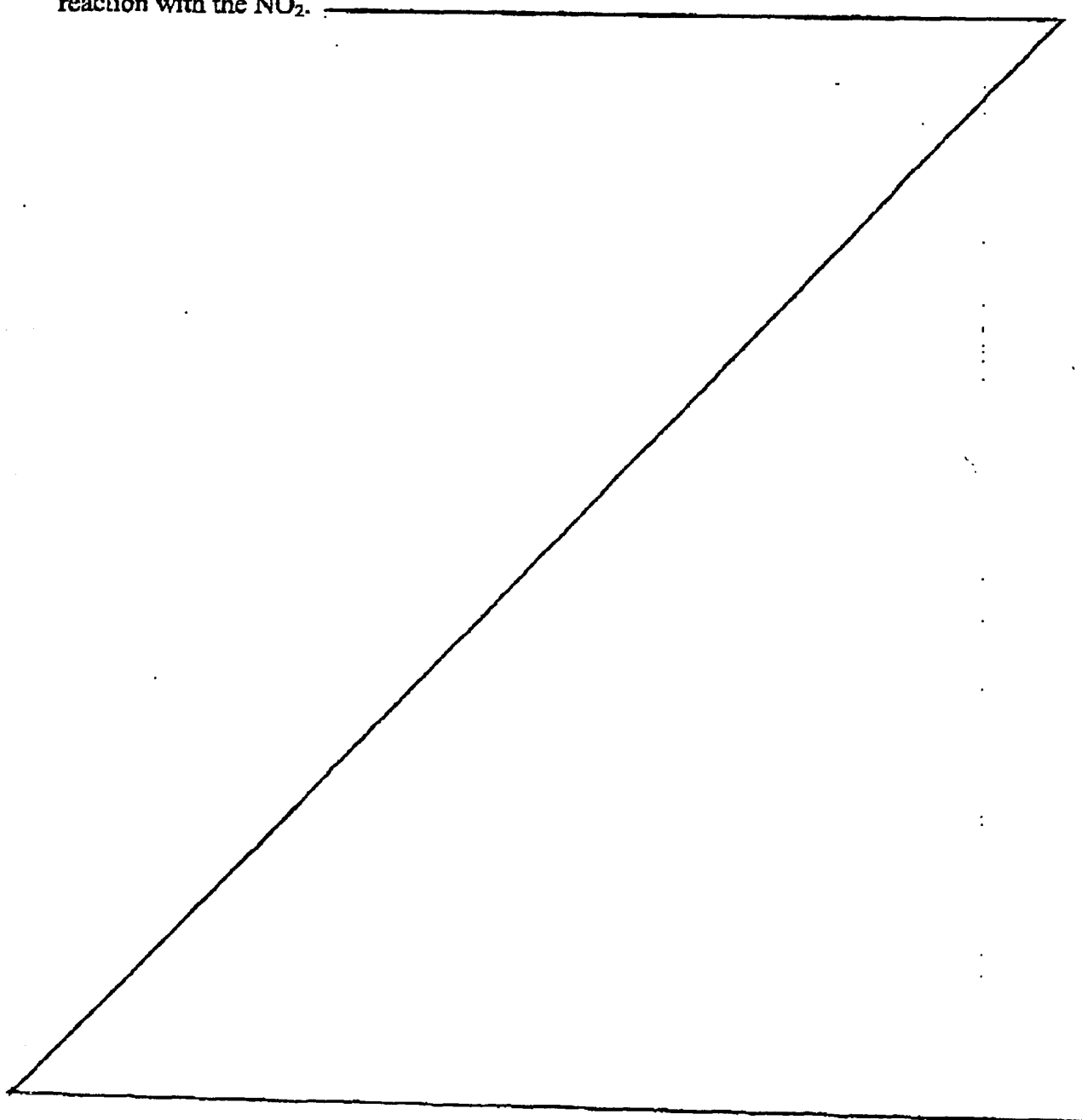
15 The present invention provides a modified diesel EGR and catalyst system,
comprising a diesel engine provided with an exhaust system, which exhaust system
comprises an oxidation catalyst and an exhaust gas recirculation system, characterised in that
the exhaust gas recirculation system intake is mounted downstream of the oxidation catalyst,
and upstream of a trap for particulates, such that the portion of exhaust gases recirculated
20 has passed through the oxidation catalyst.

Preferably, the oxidation catalyst is effective to oxidise at least a portion of NO in
the exhaust gases to NO₂, under typical conditions for said engine. More preferably, the
catalyst is a high loading platinum catalyst carried on a metal or ceramic flow-through
25 honeycomb catalyst support. Such a support may have from 50 to 800 cells/sq.in, preferably
about 400cps. The catalyst may have a loading from 10 to 150 gm Pt/cu ft of catalyst,
preferably 75 to 100g/cu ft, optionally in association with one or more other platinum group
metals and/or one or more base metal catalysts or promoters, such as Ce, V, W or Zr.

30 The present invention also provides a process for the reduction of polluting emissions
from diesel engine exhaust gas including NO_x, comprising passing the engine-out exhaust
gas through an oxidation catalyst to generate NO₂ from NO in the gas, taking a portion of
the resulting gas from the resulting gas stream and recycling said portion to the engine intake

3a

- 5 and trapping particulates in a filter mounted downstream of the point of taking the resulting gas and oxidising the particulates by reaction with at least some of the NO_2 generated by the oxidation catalyst. Preferably, at least the majority of carbonaceous particles in the remaining gases are collected on a trap and continuously or semi-continuously oxidised by reaction with the NO_2 .



The exhaust gas recirculation may be carried out using essentially well established technology, using valves in the exhaust system and a control system. It is believed that the present invention may be operated most effectively at a lower recirculation ratio (eg 5 to 30% by vol preferably 12 to 20% by vol) than is normal. Although engine intake vacuum may provide adequate EGR, it may be preferable to use pumping to provide a vacuum using a variable speed fan or pump operating under the control of the engine management unit.

Preferably, the EGR valve is mounted downstream, in the recirculation loop, of the cooler, whereby a proportion of the particulate is removed from the gases in the cooler. Since the recirculated gases are enriched with NO_2 , it is possible, depending upon gas temperatures, flow rates and residence times, for a proportion of particulates to be wholly or partially combusted within the cooler or "during flight".

It is to be realised that since only a portion of the exhaust gases is recycled, the system and process of the invention desirably include a particulate trap downstream of the EGR loop, such that all the gases fed to the exhaust outlet pipe are filtered. A preferred trap is an extruded ceramic, e.g. cordierite, wall flow filter. Other filters including metal mesh or metal or ceramic foams, may also be considered. Filters as such are not essential, if the system provides sufficient residence time for particulate to be oxidised by reaction with NO_2 in flight, possibly adhering to the front face or within the cells of catalytic components or variants on these.

The present invention is believed to offer, in its preferred embodiments, certain unexpected advantages. The invention, because it does not depend upon a NO_x reduction catalyst reaching light-off temperature, is effective to reduce NO_x at all engine operating temperatures. This has increasing importance as diesel engines are designed to give increasing efficiency and exhaust gas temperatures fall. Additionally, traditional EGR systems suffer from wear and other degradation both of the EGR valves which are used to extract the recirculating portion of the exhaust gases, and on engine or exhaust components themselves. Such degradation may lead to expensive rebuilds and engine downtime, and a system that offers the potential for savings in this area has considerable economic value.

The portion of recirculated exhaust gases is desirably cooled before being admixed with combustion air for the engine. The combustion air is desirably at super-atmospheric pressure resulting from turbo-charger or supercharger, and it is well known to cool such combustion air to increase its density before intake into the cylinders.

5

Cooling may be achieved separately or when the recirculated gases and fresh combustion air are combined. Desirably a forced air cooler is used, although a liquid (e.g. water-) cooler may be used.

10

In accordance with the principles of the present invention, the skilled person may adapt the invention to different diesel engines and in different ways achieve the benefits of the invention.

15

The present invention is illustrated with reference to the accompanying schematic drawing of one embodiment of the invention.

20

A heavy duty diesel engine is generally indicated by 1. The engine exhaust manifold, 2, connects to a turbine, 3, and feeds into an exhaust system, 4. A catalyst element, 5a, and a filter element, 5b, are mounted in a housing, 5. There is a pipe, 6, connected between the catalyst and filter elements, which can extract a portion of exhaust gas, according to the status of the exhaust flow valve described below and is the EGR intake. The portion of exhaust gas is passed to an exhaust gas cooler, generally indicated by 7, which is effective to reduce the temperature of the exhaust gas to the range 80 to 150°C. The exhaust gas cooler may be a liquid-cooled device, as shown in the drawing, or air cooled. The cooled gas then passes through an exhaust gas flow valve, 8, which is actuated under the control of an engine management unit (not shown). According to the position of the valve, exhaust gas is extracted through pipe 6 for recirculation. The engine management unit utilises conventional sensing to determine suitable load conditions for EGR operation, for example at idle and up to about half load conditions, including acceleration, but the use of EGR under full load conditions is not presently expected to be advantageous.

30

The exhaust gas is then blended with fresh air for combustion taken through an air intake, 9. Desirably an inter-cooler unit, 10, cools the combustion air and recycled exhaust gas to about 25 to 40°C before it is compressed by a turbocharger unit, 11, driven by a shaft from the turbine, 3. The charge of gas is then passed through the standard inter-cooler unit, 5 12, to cool the gas to about 35 to 60°C before it is fed to the engine.

The system of the invention, as described above, was fitted to a commercial 10 litre heavy duty engine, and tested over a variety of EGR rates. Using standardised tests, we found that engine-out NOx could be reduced by amounts from 20% to in excess of 80% in 10 proportion to increasing the EGR rate from 5% by volume recirculated to approximately 30% recirculated. As is well known, however, a fuel consumption penalty applies to EGR, and the penalty for increasing NOx reduction beyond about 90% becomes commercially unacceptable. The preferred EGR rate according to the invention is from 15 to 25%.

CLAIMS

5

1. A diesel engine (1) provided with an exhaust system (4) comprising an oxidation catalyst (5a), a particulated trap (5b) and an exhaust gas recirculation system ("EGR"), wherein the EGR system intake (6) is mounted downstream of the oxidation catalyst, so that the portion of recirculated exhaust gas passes through the oxidation catalyst, characterised in that the particulate trap is downstream of the EGR system intake.

10

2. A system according to claim 1, so arranged that all of the remainder of the un-recirculated exhaust gas passes through the particulate trap.

15

3. A system according to claim 1, wherein the particulate trap is mounted in the EGR system.

4. A system according to claim 1, 2 or 3, wherein the particulate trap is effective to trap at least 50% by wt of particulates in the exhaust gas.

20

5. A system according to claim 4, wherein the particulate trap comprises by-pass means, the arrangement being such that blocking of the filter does not cause excessive back-pressure in the exhaust system.

25

6. A system according to any preceding claim, wherein the recirculation ratio of the EGR system may be varied from 5 to 30% by volume.

7. A system according to any preceding claim, comprising a cooler (7) for the recirculated gases, said cooler being mounted upstream of an EGR valve (8).

30

8. A process for the reduction of polluting emissions from diesel engine exhaust gas including NO_x, comprising passing the engine-out exhaust gas through an oxidation catalyst to generate NO₂ from NO in the gas, taking a portion of the resulting gas from the resulting

gas stream and recycling said portion to the engine intake and trapping particulates in a filter
5 mounted downstream of the point of taking the resulting gas and oxidising the particulates
by reaction with at least some of the NO_2 generated by the oxidation catalyst.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



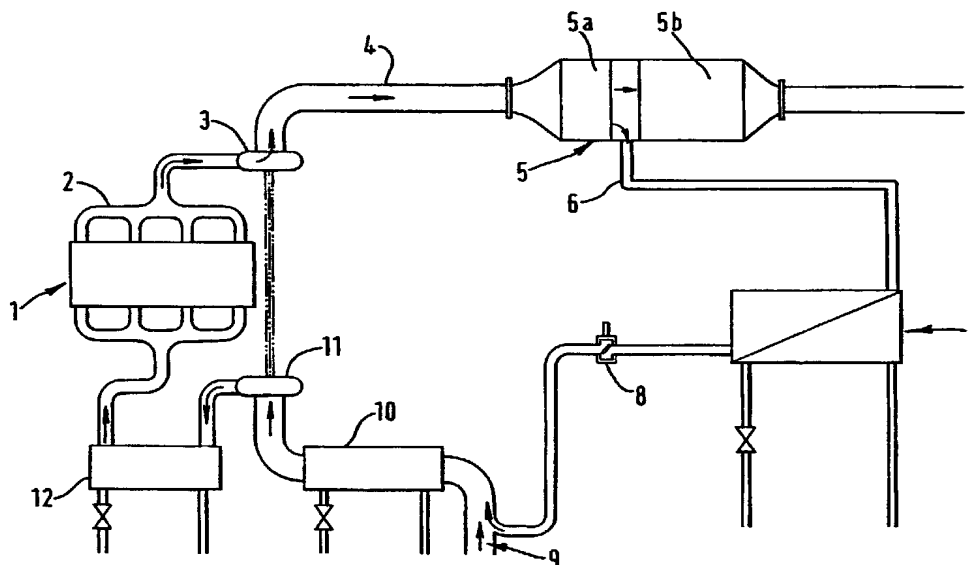
(43) International Publication Date
21 December 2000 (21.12.2000)

PCT

(10) International Publication Number
WO 00/77353 A2

- (51) International Patent Classification⁷: **F01N** (74) Agent: WISHART, Ian, Carmichael; Johnson Matthey Technology Centre, Blounts Court, Sonning Common, Reading RG4 9NH (GB).
- (21) International Application Number: PCT/GB00/02202
- (22) International Filing Date: 7 June 2000 (07.06.2000) (81) Designated State (national): US.
- (25) Filing Language: English (84) Designated States (regional): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).
- (26) Publication Language: English
- (30) Priority Data:
9913732.5 15 June 1999 (15.06.1999) GB
Published:
— Without international search report and to be republished upon receipt of that report.
- (71) Applicant (for all designated States except US): JOHN-SON MATTHEY PUBLIC LIMITED COMPANY [GB/GB]; 2-4 Cockspur Street, Trafalgar Square, London SW1Y 5BG (GB).
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
- (72) Inventor; and
(75) Inventor/Applicant (for US only): HAWKER, Pelham, Nigel [GB/GB]; The Dove House, Rectory Lane, Fowlmere, Royston SG8 7TJ (GB).

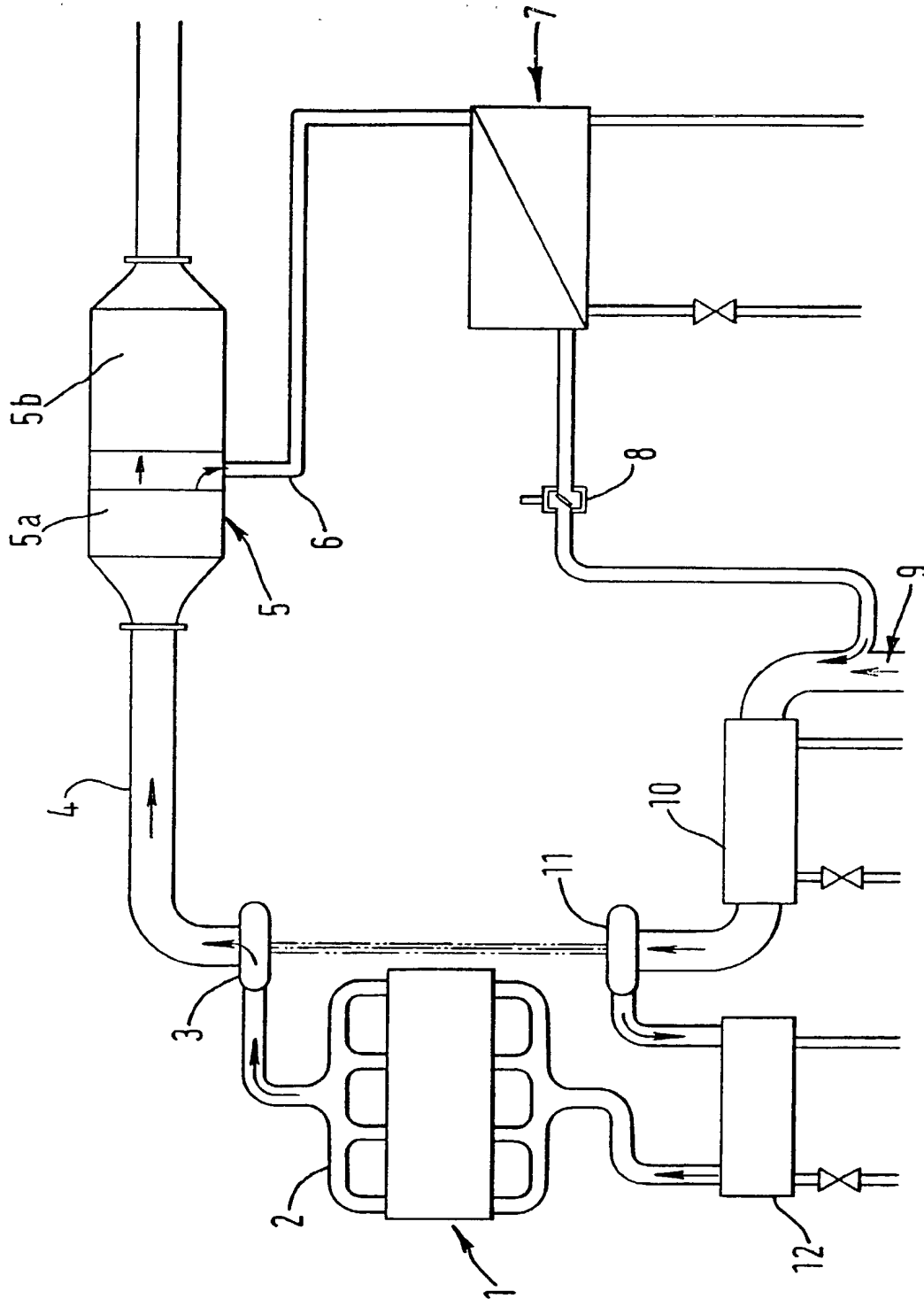
(54) Title: IMPROVEMENTS IN EMISSIONS CONTROL



(57) Abstract: A diesel engine (1) has an exhaust system (4) and an oxidation catalyst (5a). Exhaust gas for recirculation is taken through an intake pipe (6) downstream of the catalyst, and preferably upstream of a filter (5b) for soot. The recirculated gases are passed through a cooler (7) upstream of the EGR valve (8). Good removal of soot and NO_x is achieved even at low exhaust gas temperature.

WO 00/77353 A2

1/1



Declaration and Power of Attorney For Patent Application English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

IMPROVEMENTS IN EMISSIONS CONTROL,

the specification of which is attached hereto unless the following box is checked:



was filed on December 14, 2001 as

United States Application Number or PCT International Application Number 10/018,520

and was amended on by a Preliminary Amendment filed on December 14, 2001.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority Not Claimed

9913732.5

Great Britain

15 June 1999

(Number)

(Country)

(Day/Month/Year Filed)

☐

(Number)

(Country)

(Day/Month/Year Filed)

☐

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below.

(Application Number)

(Filing Date)

(Application Number)

(Filing Date)

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

PCT/GB00/0220207 June 2000Abandoned

(Application Number)

(Filing Date)

(Status - patented, pending, abandoned)

(Application Number)

(Filing Date)

(Status - patented, pending, abandoned)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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